Health Consultation

WAUCONDA SAND AND GRAVEL LANDFILL

WAUCONDA, LAKE COUNTY, ILLINOIS

EPA FACILITY ID: ILD047019732

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U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
Atlanta, Georgia 30333

Purpose

On January 13, 1995, the Agency for Toxic Substances and Disease Registry (ATSDR) released a public health assessment prepared by the Illinois Department of Public Health (IDPH) for the Wauconda Sand and Gravel Landfill site in Wauconda, Illinois. Since then the U.S. Environmental Protection Agency (USEPA) released two "5-year review reports," the most recent in August 2002. In the fall of 2003, the Lake County Health Department found groundwater contamination in private wells east of this site. The Wauconda Sand and Gravel site is a suspected source of this contamination.

The purpose of this health consultation is to evaluate the current status of the site and any environmental data collected since the release of the 1995 public health assessment.

Background and Statement of Issues

Site History

The Wauconda Sand and Gravel Landfill site is in the Village of Wauconda in Lake County, Illinois (Attachment 1). The site comprises about 74 acres, including a 47-acre non-permitted landfill, and a 6-acre landfill permitted by the Illinois Environmental Protection Agency (Illinois EPA) in 1977. The landfill began operation in 1941 on land previously used as a sand and gravel quarry. The non-permitted landfill accepted an estimated 5.4 million cubic yards of waste material including residential garbage, construction debris, and industrial waste and sludge [a]. The permitted landfill operated until July 1978.

After closure, leachate began to seep from the landfill. An anonymous caller reported that several million pounds of polychlorinated biphenyl (PCB) waste was in the landfill [b]. Several environmental investigations by Illinois EPA and USEPA led to the site's placement on the National Priorities List (NPL) in September 1983.

A remedial investigation and feasibility study resulted in the construction of a perimeter fence, repair to the landfill cover, and installation of a leachate collection system. The perimeter fence restricts access to the site. The improved landfill cap reduces water infiltration into the landfill. The leachate collection system prevents contaminated leachate from leaving the site. The alleged PCB contamination—a reason for the placement of the site on the NPL—was found only in two leachate samples in the early 1990s [a].

Past Health Evaluations

On January 13, 1995, ATSDR released a public health assessment prepared by IDPH for the Wauconda Sand and Gravel Landfill. IDPH concluded that the site posed no apparent public health hazard. While the risk of groundwater contamination was greatest for shallow wells northeast (downgradient) of the site, there were no known completed exposure pathways. IDPH recommended continued groundwater monitoring and continued restriction of site access [a].

USEPA Site Evaluation

In April 2002, USEPA staff inspected the Wauconda Sand and Gravel Landfill, and in August 2002, issued the second 5-year review report for the site. USEPA concluded,

> ". . . some contaminants such as vinyl chloride, benzene, chloride, and sodium have slightly exceeded the maximum contaminant levels or the action level at a few groundwater monitoring wells or residential wells. However, at this time, these exceedances do not appear to affect the protectiveness of the remedy since there is a downward trend in the contaminant concentrations." [b]

The residents whose private wells had contaminants at levels greater than drinking water standards were connected to the Village of Wauconda public water system. As part of the continuing operations and maintenance plan for the site, the Wauconda Task Group is to

- Visually inspect and maintain the landfill cap,
- Inspect the drainage ditches for any needed maintenance or corrective action,
- Inspect the condition of groundwater monitoring wells,
- Monitor the leachate collection system,
- Sample groundwater monitoring wells and 5 residential wells annually and a designated well monthly, and
- Sample the leachate collection system quarterly [b].

2003 Residential Groundwater Contamination

On September 15, 2003, the Lake County Health Department (LCHD) sampled six residential wells east of the site along Garland and Wade streets (Attachment 1). One well had a detection of vinyl chloride at 1.4 micrograms per liter (µg/L). LCHD re-sampled this well in October and found 1 µg/L of vinyl chloride. In November, LCHD expanded their sampling to include six more wells on Garland, Wade, and Gardner streets. Three of these wells contained vinyl chloride at levels ranging from 0.6 to 2 µg/L. Five more wells in the area were sampled in December, and vinyl chloride was detected in three of them.

In all, LCHD sampled 17 private wells in 2003 (some on multiple occasions), and vinyl chloride was detected in 7 wells, with the highest level of detection at 3.6 µg/L. The maximum contaminant level (MCL) for vinyl chloride in public water supplies is 2 µg/L. This MCL was exceeded in 3 of the 7 wells. In some wells, other chlorinated solvents were detected at trace levels.

LCHD consulted with ATSDR and IDPH about a health-based interpretation of the results of these samples. On January 13, 2004, LCHD hosted a public meeting to explain the results of the sampling to area residents. USEPA is working to determine the source of the vinyl chloride. A contractor for the Wauconda Task Group will conduct expanded private well sampling in the area and provide bottled water to residents whose wells contain more than 1 µg/L of vinyl chloride (Ron Frehner, Conestoga-Rivers & Associates, personal communication, Jan. 2004).

Discussion

IDPH compared the results of each groundwater sample with the appropriate screening comparison values used to select chemicals for further evaluation for carcinogenic and non-carcinogenic health effects. Chemicals found at levels greater than comparison values or those for which no comparison value exists were selected for further evaluation. A brief explanation of each comparison value used is found in Attachment 2.

Although other chlorinated solvents including chloromethane, dichlorodifluromethane, and cis, 1-2-dichloroethene have been detected at trace levels, vinyl chloride remains the principal chemical of interest found in the fall 2003 private well samples.

Exposure Evaluation

An exposure pathway consists of: 1) a source of contamination, 2) environmental media and transport mechanisms, 3) a point of exposure, 4) an exposure route, and 5) a receptor population. If all of these elements are identified, then a complete exposure pathway exists. When one or more of these elements is missing, a potential exposure pathway exists; that is, exposure to a contaminant may have occurred in the past, may be occurring now, or may occur in the future.

ATSDR establishes minimal risk levels (MRLs), which are doses in humans below which no adverse health effects would be expected. Exceeding an MRL does not mean that adverse health effects will occur. Prudent public health practice requires public health officials to look closely at studies used to derive MRLs to determine whether any adverse effects could occur.

Ingestion

IDPH assumed that adult residents drink 2 liters of well water per day and children drink 1 liter per day. IDPH assumed residents would use well water containing 0.0036 milligrams of vinyl chloride per liter of water (mg/L)—the highest level detected in private wells to date. The estimated ingestion dose was calculated using the following formula:

Estimated ingestion dose = water concentration (mg/L) x drinking rate (L/day) / bodyweight (kg)

The estimated daily dose from drinking water was 0.0001 milligrams of vinyl chloride per kilogram of body weight per day (mg/kg-day) for adults and 0.0003 mg/kg-day for children. The ATSDR chronic MRL for ingestion of vinyl chloride is 0.00002 mg/kg-day.

Drinking the level of vinyl chloride detected in the well water would not be expected to cause short-term adverse health effects. The greater potential for adverse health effects is for persons drinking vinyl chloride in their water for prolonged periods of their lifetime. Persons drinking the maximum level of vinyl chloride detected in the well water over their lifetime may have a very low increased risk of developing liver cancer.

Inhalation

IDPH also assumed that residents would be exposed to vinyl chloride vapor released into indoor air during household water use, primarily during showering or bathing. To estimate an inhalation dose from showering, IDPH assumed that a resident would spend 15 minutes in the bathroom shower each day. The flow rate of water through the showerhead was estimated to be 8 liters per minute (L/min), and the volatilization rate of vinyl chloride from the water to the air was 90%. The estimated volume of the bathroom was 10 cubic meters (m^3). The estimated breathing rate for adults was 20 cubic meters per day (m^3/day) or 0.014 cubic meters per minute (m^3/min). For children, the estimated breathing rate was 10 m^3/day (0.007 m^3/min). The estimated inhalation dose was calculated using the following formula:

Estimated inhalation dose = $C \times 0.9 \times F \times T \times B \times T / V \times BW$, where

C = vinyl chloride concentration in water (mg/L)
0.9 = volatilization rate of vinyl chloride from water to air (90%)
F = flow rate of water through the showerhead (8 L/min.)
T = a person's time in shower (15 min.)
B = breathing rate (0.014 m^3/min for adults; 0.007 m^3/min for children)
V = volume of bathroom (10 m^3)
BW = body weight (70 kg for adults; 35 kg for children)

Using these assumptions, the estimated vinyl chloride concentration in bathroom air would be 43 micrograms per cubic meter ($\mu g/m^3$). This results in an estimated daily inhalation dose of 0.0001 mg/kg-day for adults and 0.0004 mg/kg-day for children.

Because ATSDR does not have a chronic MRL for inhalation of vinyl chloride, IDPH used toxicity data published on-line by the Oak Ridge Operations Office of the U.S. Department of Energy [c]. Oak Ridge has published a chronic inhalation reference dose of 0.0286 mg/kg-day, which is about 70 times greater than the estimated child inhalation dose and about 285 times greater than the estimated adult inhalation dose. Therefore, non-cancer adverse health effects would not be expected from breathing vinyl chloride vapor while showering.

Using Oak Ridge inhalation cancer risk data, persons whose shower water contains the maximum level of vinyl chloride found in well water near the Wauconda Sand and Gravel Landfill would not have an increased risk of developing cancer over their lifetime.

IDPH also considered toxicological information available at the USEPA Integrated Risk Information System (IRIS) Web site [d]. The USEPA reference concentration for vinyl chloride is 100 $\mu g/m^3$. A reference concentration is the level of a chemical below which no adverse health effects would be expected to occur based on a 24 hour-per-day exposure over an entire lifetime. The estimated concentration of vinyl chloride in the bathroom is about one-half of the USEPA reference concentration, and no apparent increased cancer risk would be expected.

Dermal

Only about 1% of vinyl chloride is absorbed through the skin. Animal data suggest that the skin does not easily absorb vinyl chloride vapor [5]. An ATSDR technical consultation (2003) suggested that the dermal dose from showering can be conservatively estimated to be equal to the inhalation dose; but this does not take into account the poor dermal absorption of vinyl chloride [6]. Because of these factors, IDPH does not consider skin absorption to contribute significantly to exposure as compared to ingestion and inhalation.

Toxicological Evaluation

The MRL for vinyl chloride is based on an animal study in which the liver cells of rats were affected by ingestion of vinyl chloride in their food. Persons drinking well water with 0.0036 mg/L of vinyl chloride will exceed the MRL; nevertheless, the dose at which humans could experience adverse non-cancer liver effects is likely much higher [5].

Vinyl chloride is one of the most studied human carcinogens. The liver is the primary target organ for this chemical, which causes a type of cancer known as liver angiosarcoma [5]. Persons drinking the maximum level of vinyl chloride detected in the well water over their lifetime may have a very low increased risk of developing liver cancer. Based on the low level and short duration of exposure to date, we would not expect to see cases of liver angiosarcoma.

Based on data from human epidemiological studies of workers exposed to the chemical by inhalation, vinyl chloride is classified by USEPA as a known human carcinogen. Vinyl chloride is also considered to be a human carcinogen by the oral route of exposure based on animal studies and human pharmacokinetic data. Because it is well absorbed orally and acts systematically, vinyl chloride also is considered highly likely to be a human carcinogen by dermal exposure [5]. For more information about the cancer risk of vinyl chloride, see Attachment 3.

The International Program on Chemical Safety has noted that vinyl chloride is a genotoxic carcinogen and exposures should be kept as low as possible [6].

Child Health Considerations

IDPH recognizes that children are especially sensitive to some contaminants. For that reason, IDPH considered children when evaluating exposures to chlorinated solvents in the water near the Wauconda Sand and Gravel site. Children are the most sensitive population considered in this health consultation. No short-term adverse health effects would be expected for children exposed to the levels of vinyl chloride in the water near the site. Persons exposed to the maximum level of vinyl chloride detected in the well water over their lifetime may have a very low increased risk of developing liver cancer.

The use of bottled water has helped to reduce current overall child exposures. Cooking, dishwashing and bathing (especially small children) are additional exposure pathways that could increase dermal, inhalation and oral exposures to children. Children may adapt well to the interim use of bottled water for drinking, but there can be concerns about continued use over time.

Conclusions

Given the data reviewed, IDPH concludes that the levels of vinyl chloride detected in private wells east of the Wauconda Sand and Gravel Landfill site to date do not present a short-term public health hazard. Past exposure conditions likely do not pose a public health hazard. Providing bottled water to homes with vinyl chloride levels in their wells greater than 1 µg/L is an interim measure that has reduced overall exposure. Because of this, current exposure conditions likely do not pose a public health hazard. A long-term solution is needed since inhalation exposure is still occurring and bottled water is only an interim measure. Without a more permanent solution, the vinyl chloride detected in private wells east of the Wauconda Sand and Gravel Landfill site could pose a public health hazard for people drinking this water for prolonged periods over the course of their lifetimes. The source of vinyl chloride in these wells is still under investigation.

Previous evaluations suggested a downward trend in environmental levels of vinyl chloride [2]; however, based on the 2003 private well samples, there is now a concern that exposure levels could increase over time. Providing bottled water interrupts the current ingestion exposure pathway, but is (1) only an interim measure, (2) does not address all exposure pathways, and (3) requires a change in behavior for residents. Long-term compliance with using bottled water is neither predictable nor necessarily reliable. Without a more permanent solution, exposures could increase in the future.

Recommendations

IDPH recommends that:

- Residents with affected groundwater use an alternate water source for drinking and cooking. A contractor for the Wauconda Task Group will be providing bottled water to residents whose well sampling results for vinyl chloride are greater than 1 µg/L. This is an interim measure until a longer-term solution is reached. Residents may also consider use of a drinking water treatment unit designed to remove volatile organic chemicals. Residents should consult with manufacturers to ensure the system will perform properly to remove vinyl chloride.

- The Wauconda Task Group contractor, with USEPA oversight, conduct further well water sampling to learn the extent of the vinyl chloride contamination.

- USEPA oversee an investigation of the source of the vinyl chloride contamination.

- As part of the continuing operations and maintenance plan for the Wauconda Sand and Gravel site, the Wauconda Task Group will comply with USEPA recommendations.

Public Health Action Plan

In early 2004, with the agreement of IDPH and LCHD, the Wauconda Task Group began providing bottled water to homes with vinyl chloride levels in their wells greater than 1 µg/L. This interim measure has reduced exposure by ingestion and reduced overall exposure to where it no longer poses a public health hazard. However, because inhalation exposure is still occurring and bottled water is an interim measure, a long-term solution is still needed.

As more information is learned about the nature and extent of the groundwater contamination, IDPH will continue to work with LCHD to assist in the interpretation of sample results, and work with USEPA to provide input on future actions. IDPH will provide information to area residents at a public meeting scheduled for May 19, 2004.

Author

Ken Rumkle
Environmental Toxicologist
Illinois Department of Public Health

Technical Advisors

Allen Robison, Steve Inserra, Michelle Watters
Agency for Toxic Substances and Disease Registry

Certification

The Illinois Department of Public Health prepared this Wauconda Sand and Gravel site health consultation under a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It was done in accordance with methods and procedures approved at the time the health consultation was begun.

W. Allen Robison, Ph.D.

Technical Project Officer
Superfund Site Assessment Branch (SAAB)
Division of Health Assessment and Consultation (DHAC)

The Division of Health Assessment and Consultation, ATSDR, has reviewed this health consultation and concurs with its findings.

Roberta Erlwein

Team Leader, State Programs
SSAB, DHAC, ATSDR

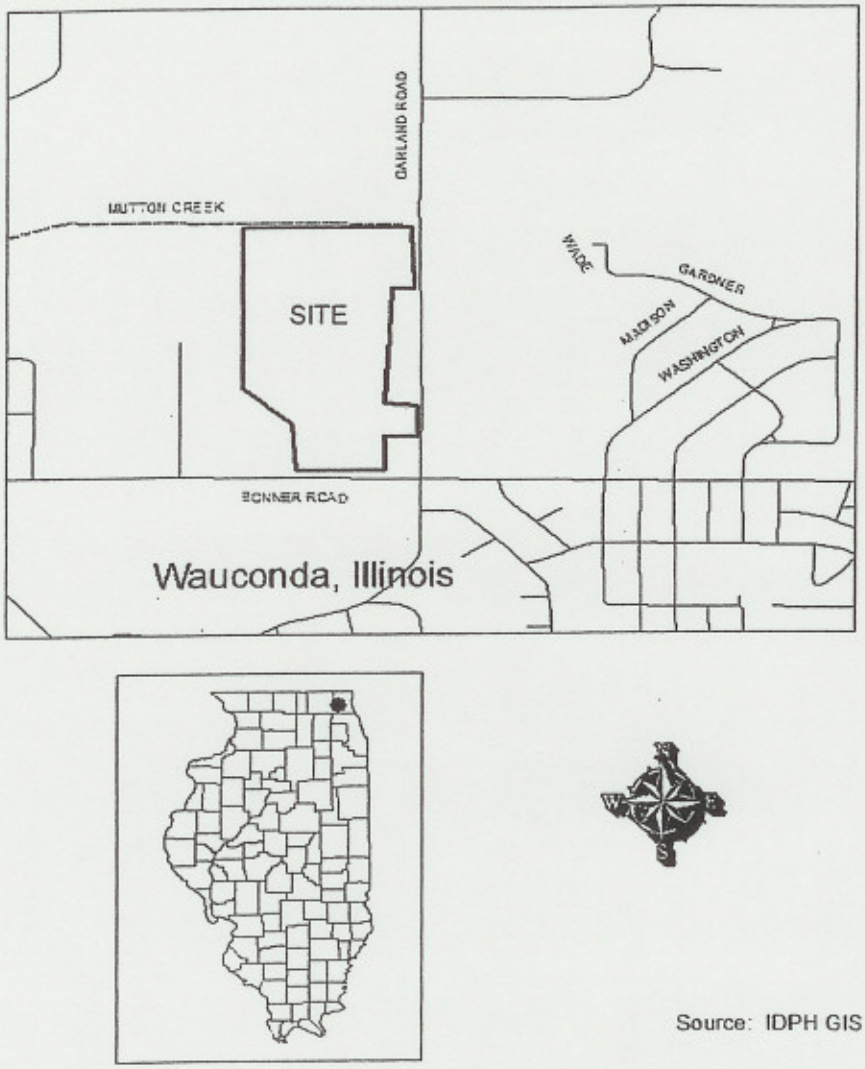
References

a. Agency for Toxic Substances and Disease Registry. Health assessment for Wauconda Sand and Gravel Landfill site, Wauconda, Illinois. Atlanta: US Department of Health and Human Services; 1995 Jan 13.

Attachment 1: Approximate Location of Wauconda Sand and Gravel Landfill

Attachment 1

Approximate Location of Wauconda Sand and Gravel Landfill



Source: IDPH GIS

Attachment 2: Comparison Values Used in Screening Contaminants for Further Evaluation

Environmental media evaluation guides (EMEGs) are developed for chemicals on the basis of their toxicity, frequency of occurrence at National Priorities List (NPL) sites, and potential for human exposure. They are derived to protect the most sensitive populations and are not action levels, but rather comparison values. They do not consider carcinogenic effects, chemical interactions, multiple route exposure, or other media-specific routes of exposure, and are very conservative concentration values designed to protect sensitive members of the population.

Reference dose media evaluation guides (RMEGs) are another type of comparison value derived to protect the most sensitive populations. They do not consider carcinogenic effects, chemical interactions, multiple route exposure, or other media-specific routes of exposure, and are very conservative concentration values designed to protect sensitive members of the population.

Cancer risk evaluation guides (CREGs) are estimated contaminant concentrations that are based on a probability of 1 excess cancer in 1 million persons exposed to a chemical over a lifetime. These are also very conservative values designed to protect sensitive members of the population.

Maximum contaminant levels (MCLs) have been established by USEPA for public water supplies to reduce the chances of adverse health effects from contaminated drinking water. These standards are well below levels for which health effects have been observed and take into account the financial feasibility of achieving specific contaminant levels. These are enforceable limits that public water supplies must meet.

Lifetime health advisories for drinking water (LTHAs) have been established by USEPA for drinking water and are the concentration of a chemical in drinking water that is not expected to cause any adverse noncarcinogenic effects over a lifetime of exposure. These are conservative values that incorporate a margin of safety.

Attachment 3: Vinyl Chloride and Cancer Risk

Based on data from human epidemiological studies of workers exposed to the chemical by inhalation, vinyl chloride is classified by USEPA as a known human carcinogen. Vinyl chloride is also considered to be a human carcinogen by the oral route of exposure based on animal studies and human pharmacokinetic data. Because it is well absorbed and acts systematically, vinyl chloride also is considered likely to be a human carcinogen by dermal exposure (e).

Vinyl chloride is one of the most comprehensively studied human carcinogens. The liver is the primary target organ for this chemical, which causes a type of cancer known as liver angiosarcoma. This cancer is caused by a reactive metabolite (chloroethlyene oxide), which binds to DNA and results in uncontrolled cell growth and tumor formation (d, e; Albertini et al 2003).

Vinyl chloride has a relatively high oral cancer slope factor of 0.72 $(mg/kg\text{-}day)^{-1}$ for continuous lifetime exposure during adulthood. This slope factor doubles to 1.4 $(mg/kg\text{-}day)^{-1}$ when considering continuous lifetime exposures from birth. This approach is supported by a study with rats where angiosarcoma incidence after short-term early life exposure was approximately equal to that of long-term exposure starting after maturity (Morinello et al 2000; Albertini et al 2003).

About one of every three people (33%) in the U.S. develops some type of cancer over their lifetime (ATSDR). Cancer risks from exposures to carcinogens are estimated by using mathematical models to calculate maximum likely additional theoretical cancer risks. People drinking the maximum level of vinyl chloride (3.6 µg/L) detected to date in groundwater wells near the Wauconda Sand and Gravel Landfill over their adult lifetime may have a low additional risk of developing cancer ($7x10^{-5}$). This means that in a population of 100,000 people exposed during adulthood, an additional 7 cancer cases could occur above and beyond the 33,333 (33%) that would be expected. The risk of additional cancer cases could be increased by multiple exposure pathways (oral, inhalation, and dermal).

For continuous lifetime exposure from birth, the estimated maximum additional cancer risk is about $2\,x10^{-4}$. This means that in a population of 100,000 people exposed from birth, up to 20 additional cancer cases could occur above and beyond the 33,333 (33%) that would be expected. This risk could be increased by multiple exposure pathways (oral, inhalation, dermal).

Additional References

Albertini, R., H. Clewell, M.W. Himmelstein, E. Morinello, S. Olin, J. Preston, L.Scarano, M.T> Smith, J. Swenberg. R.Tice, and C. Travis. 2003. The use-of non-tumor data in risk assessment: reflections on butadiene, vinyl chloride and benzene. Regulatory Toxicology and Pharmacology 37:105-132.